

HP-39/40 RPN Add-On

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The HP39/40 calculators do not offer a RPN calculation mode, which otherwise is a hallmark of HP calculators.

This program implements a scientific RPN calculator providing

- a four-level RPN stack including stack manipulation and Last-X register,
- the real number functions of the calculator operating on the stack content.



The program does not use an input form to get input values, but composes them in the display line of the X-register as the number keys are pressed.

Altogether the implementation aim was to create a user interface with

- the look of the HP-39/40 HOME environment,
- the RPN logic known from HP RPN calculators.

The content of the stack registers is stored in the HOME variables X, Y, Z, T and L. They are not cleared, when the RPN Add-On is started, so that the stack may appear already containing values. Especially, the stack will remain unchanged when the PRN Add-On is re-started, if these variables remained untouched in the meantime.

Basic Operation

The RPN Add-On is implemented as a program and must therefore be started from the program catalog, unless it was assigned to the VIEWS menu.

Start the RPN Add-On – **SHIFT** **PROGRM** **RPN** **START**.

Start the RPN-Add-On. Thereby the

- list variable L0 is initialized, i.e. its content is overwritten,
- graphic variables G0 and G9 are initialized, i.e. their content is overwritten,
- matrices M0 and M9 are re-dimensioned, but the remaining content is not deleted.

Quit the RPN Add-On – **HOME**, **ON**.

Quit he RPN Add-On without any further action..

The RPN Add-On consists of three components:

- RPN: Core program providing RPN logic and keyboard-assigned functions
- RPN.EXT2: Additional functions that are accessible via menus
- RPN.STAT: Additional statistical functionality

The RPN core program will work also, if the extensions are not installed. In that case pressing a related key will have no effect.

Display

The RPN Add-On presents the entire stack on the screen.

- Stack area: Y, Z, T-registers
- Input line: X-register

The active angle mode is displayed in the title line:

The graphic variable G0 and G9 are used to store

- G0: the background image of the RPN Add-On,
- G9: the annunciator representing the current angle mode.



Number entry

The display line for the X-register is also the input line for new values.

When a number key is pressed, the previous content of the X-register is overwritten. If automatic stack lift is enabled, the stack is lifted before number entry is processed.

Automatic stack lift is:

- Enabled, after a function has returned a value to the X-register,
- Disabled, after a manual stack lift using ENTER and after clearing the X-register using DEL or CLEAR.

Note: On the G-models number input is a little sluggish due to the slower processing speed.

Enter a value – **0**, **9**, **.**, **(-)**, **SHIFT** **EEX**.

Enter a number into the X-register.

Delete a value – **DEL**.

Clear the X-register, leaving it set to 0. (Additionally automatic stack lift is disabled.)

The HOME variables K, N, M, E are used to record

- K: the key code of the last keystroke,
- N: the value of the number related to that key,
- M: the mantissa entered so far,
- E: the exponent entered so far.

Stack Operation

Lift the stack – **ENTER**.

Lift the stack copying the register contents $Z \rightarrow T$, $Y \rightarrow Z$, $X \rightarrow Y$.

The content of register T is lost.

Rotate the stack – **▲**, **▼**.

Rotate the stack

- **▲**: upwards, i.e. $X \rightarrow Y \rightarrow Z \rightarrow T \rightarrow X$
- **▼**: downwards, i.e. $X \rightarrow T \rightarrow Z \rightarrow Y \rightarrow X$

Exchange X- and Y-registers – **◀**, **▶**.

Exchange the contents of the X- and Y-registers, $X \leftrightarrow Y$.

Clear the stack – **SHIFT** **CLEAR**.

Clear all stack registers, leaving them set to 0.

Recall last X-value – **SHIFT** **ANS**.

Recall the value X had before the last operation to the X-register.

View last X-value – **ALPHA** **ANS**.

View the value X had before the last operation, without changing the X-register.

Press any key to return to the RPN stack display.



View mantissa – **X**, **T**, **q**.

View the mantissa of X, i.e. the full accuracy of X, without changing the X-register.

Press any key to return to the RPN stack display.



Memory Functions

Values can be stored into ten storage registers numbered 1 – 10.

Store value – **STO** **n**.

Copy the value in the X-register to storage register *n*.

An annunciator (>) in the input line indicates that a register number must be entered. (0 stands for register 10)

Press **STO** again to cancel the operation.



Recall value – **RCL** **n**.

Recall the value in storage register *n* to the X-register.

An annunciator (<) in the input line indicates that a register number must be entered. (0 stands for register 10)

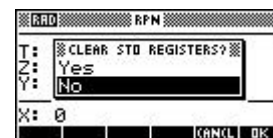
Press **RCL** again to cancel the operation.



Delete stored values – **CLRM**.

Clear all storage registers, leaving them set to 0.

Confirmation is requested.



The values are stored in matrix M0.

The matrix variable is re-dimensioned (but not cleared) to represent a 10-element vector when the RPN Add-On is started. Thus stored values can remain accessible if the RPN Add-On is terminated and re-started later.

Edit stored values – **VAR**.

Open the matrix M0, which holds the storage registers, in the Matrix Editor.



Format Settings

The RPN Add-On uses the format settings stored in the home variables

- HFormat: Number format
- HDigits: Display precision
- HAngle: Angle measure

The settings can be changes using dedicated menus.

Set display format – **ALPHA** **MODES** **Standard / Fixed / Scientific / Engineering / Fraction**.

Display a menu to select the display format.

If a format different from “Standard” is selected, a second menu is displayed to chose the display precision.

Press **CANCL** in either of the menus to leave the current settings unchanged.



Set angle mode – **SHIFT** **MODES** Degrees / Radi ans / Grads.

Display a menu to select the angle mode.

Press CANCL to leave the current settings unchanged.



Mathematical Functions

The functions work on the values stored in the stack and return their results to the stack.

One parameter	Two parameters	Two pars and results
T → T	T → T	T → T
Z → Z	Z → T	Z → Z
Y → Y	Y → Z	Y → $f_Y(X, Y)$
X → $f(X)$	X → $f(X, Y)$	X → $f_X(X, Y)$

Additionally the value of the X-register is saved to the L-register, before executing a function.

If a function is executed with an inappropriate input value, the X-register is cleared and the message “Error” is displayed in place of the X-register content.



Press any key to return to the RPN stack display.

Note: The value causing the error can be retrieved afterwards from the L-register.

Basic Arithmetic

Basic arithmetical operations – **+**, **-**, **÷**, **×**.

Return the sum, difference, product or quotient of Y and X.

Negative – **(-)**.

Return the negative of X.

Inverse – **SHIFT** **X⁻¹**.

Return the inverse of X.

Powers

Square and square root – **X²**, **SHIFT** **ö---**.

Return the square or square root of X.

Power and nth root – **X^Y**, **SHIFT** **nö---**.

Return the Xth power or Xth root of Y.

Logarithms

Natural logarithm and antilogarithm – **In**, **SHIFT** **e^x**.

Return the natural logarithm or antilogarithm of X.

Decimal logarithm and antilogarithm – **log**, **SHIFT** **10^x**.

Return the decimal logarithm or antilogarithm of X.

Shifted natural logarithm and antilogarithm – **ALPHA** **In**, **ALPHA** **SHIFT** **e^x**.

Return the function result of ln(1+X) or e^X-1 respectively.

This is useful when x is close to 0: $x \approx 0 \Rightarrow$

- $(1+x)^n \approx 1$; the replacement $(1+x)^n = e^{n \times \ln(1+x)}$, yields a better accuracy
- $e^x \approx 1$; subtracting 1 from the result, yields more significant digits

Trigonometric Functions

Trigonometric functions – **SIN**, **COS**, **TAN**.

Return the sine, cosine, tangens of X.

Inverse trigonometric functions – **SHIFT ASIN**, **SHIFT ACOS**, **SHIFT ATAN**.

Return the inverse sine, cosine, tangent of X.

Constant π – **SHIFT p**.

Return the value of π .

Additional trigonometric functions – **SHIFT D** **COT / SEC / COSEC / ACOT / ASEC / ACOSEC**.

Display a menu to select the function and return the related result.

- COT: Cotangent
- SEC Secant
- COSEC: Cosecant.
- ACOT: Inverse cotangent
- ASEC: Inverse Secant
- ACOSEC: Inverse cosecant.

Note: The additional functions are not available if the program *RPN.EXT2* is not loaded.

In this case, pressing **SHIFT** \neq will produce an error.

Hyperbolic Functions

Hyperbolic functions – **ALPHA SIN**, **ALPHA COS**, **ALPHA TAN**.

Return the hyperbolic sine, cosine, tangent of X.

Inverse hyperbolic functions – **ALPHA ASIN**, **ALPHA ACOS**, **ALPHA ATAN**.

Return the inverse hyperbolic sine, cosine, tangent of X.

Combinatorial Functions

Factorial – **SHIFT !**.

Return the factorial of X.

Permutations – **SHIFT P**.

Return the number permutations of X elements out of a set of Y elements.

Permutations – **SHIFT Q**.

Return the number of combinations of X elements out of a set of Y elements.

Conversion Functions

The conversion functions are accessible in a menu assigned to the MATH key.

Note: The conversion functions are not available if the program *RPN.EXT2* is not loaded.

In this case, pressing MATH will produce an error.

Angle measure conversions – **MATH DEG→RAD / RAD→DEG**.

Return the angle in X converted from degrees to radians or vice versa.

Angle representation conversions – **MATH H→HMS / HMS→H**.

Return the decimal angle or time in X converted to HMS format or vice versa.

Coordinate conversions – **MATH P→R / R→P**.

Return the Cartesian coordinates (x,y) in X and Y converted into polar coordinates (r,q) with r in X and q in Y or vice versa..

Percentage functions

Percentage – **d/dx**.

Return the percentage of Y given in X, i.e. $Y \times X/100$.

The stack is not dropped so that the original value of Y remains unchanged.

This is useful to calculate a mark-up or discount by a subsequent + or – operation.

Percentage change – **SHIFT d/dx**.

Return the percentage change from the value in Y to that in X, i.e. $(X-Y)/Y \times 100$.

Percentage of total – **ALPHA d/dx**.

Return the percentage X represents in a total of Y, i.e. $X/Y \times 100$.

Number manipulation

These functions are accessible in a menu assigned to the shifted MATH key.

Note: These functions are not available if the program *RPN.EXT2* is not loaded.

In this case, pressing SHIFT MATH will produce an error.

Round – **SHIFT MATH ROUND**.

Round the value in X to the current display accuracy.

Truncate – **SHIFT MATH TRUNCATE**.

Truncate the decimals of the value in X exceeding the current display accuracy.

Largest smaller integer – **SHIFT MATH FLOOR**.

Return the largest integer that is smaller or equal to the value in X.

Smallest larger integer – **SHIFT MATH CEILING**.

Return the smallest integer that is larger or equal to the value in X.

Integer part – **SHIFT MATH INT**.

Return the integer part of the value in X, i.e. truncate all decimals.

Fractional part – **SHIFT MATH FRAC**.

Return the fractional part of the value in X, i.e. $X - \text{INT}(X)$.

Mantissa – **SHIFT MATH MANTISSA**.

Return the mantissa of the value in X, i.e. $X / \text{FLOOR}(\text{LOG}(X))$.

The value range of the mantissa is: $1 \leq \text{MANT}(X) < 10$.

Exponent – **SHIFT MATH XPON**.

Return the exponent of the value in X, i.e. $\text{FLOOR}(\text{LOG}(X))$.

$X = \text{MANT}(X) \times 10^{\text{XPON}(X)}$.

Statistics

The statistics functions of the RPN Add-On are an implementation independent of those of the Statistics Aplet. They work from summation values. The individual data points are not stored.

The list variable L9 is used to store the statistical data:

- L9(1) – L9(6): Input sums (n , Σx , Σy , Σx^2 , Σy^2 , Σxy)
- L9(7) – L9(17): Output values

Note: The statistics functions are not available if the program *RPN.STAT* is not loaded.

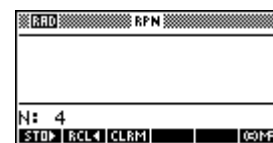
In this case, pressing a related key will produce an error.

Data Entry

The data entry functions always process the values from registers X and Y. In order to perform one-variable statistics simply ignore the y-related values and functions.

After every entry or deletion of a data point, the current number of summed up data points is displayed. Press any key to return to the RPN stack display and to continue data entry.

The stack content remains unchanged. Thus a value pair can be entered repeatedly.



Enter data point – \square , \square .

Add the values of X and Y to the summation registers.

Delete data point – **SHIFT** \square , \square .

Remove the values of X and Y from the summation registers.

Summation data – **ALPHA** **S** $n / \Sigma x / \Sigma y / \Sigma x^2 / \Sigma y^2 / \Sigma xy$.

Present a menu to select a summation value and return that value to register X.

Clear statistical data – **ALPHA** \square , \square .

Clear all statistics registers, leaving them set to 0.

Confirmation is requested.



Statistical Measurements

The statistical measurements can be retrieved from a menu assigned to the shifted + key.

Mean – **SHIFT** **S** \bar{x} / \bar{y} .

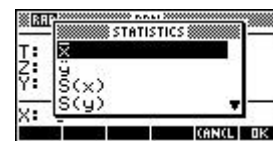
Return the arithmetic mean of the x- or y-values.

Population standard deviation – **SHIFT** **S** $S(x) / S(y) / S(x, y)$.

Return the population standard deviation of the x- or y-values or of the value pairs.

Sample standard deviation – **SHIFT** **S** $\sigma(x) / \sigma(y) / \sigma(x, y)$.

Return the sample standard deviation of the x- or y-values or of the value pairs.



Linear Regression

The regression parameters can be retrieved from the same menu as the statistical measurements.

Correlation coefficient – **SHIFT** **S** r .

Return the correlation coefficient of the x- and y-value sets.

Slope of regression line – **SHIFT** **S** m

Return the slope of the linear regression line.

Y-intercept of regression line – **SHIFT** **S** m

Return the y-intercept of the linear regression line.

Calculate estimate – **SHIFT** **X**.

Calculate an estimate for the x-value based on the y-value in register X and the regression parameters.

Calculate estimate – **SHIFT** **Y**.

Calculate an estimate for the y-value based on the x-value in register X and the regression parameters.

